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SCIENCE, TECHNOLOGY, AND MANAGEMENT: AN OVERVIEW*

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From the very beginning, the history of man has involved continuing efforts to understand nature and to adapt his physical environment to his benefit. Parallel efforts have been devoted to man's attempts to understand himself and to develop social organisations as frameworks for group efforts. Man's use of knowledge about his environment has outstripped his ability to develop human relationships necessary to enhance his total well-being. The conflict between these two cultures—the scientific and the humanistic—has been intensified during the twentieth century.[1]

Science and technology are concerned with accelerating the conquest of nature which began in prehistory and proceeded in spite of superstitions, of magic, and of other restrictions. For many centuries Aristotelian science dominated Western thought with the belief that man could develop an understanding of his environment by reasoning from self-evident principles. The goal of this philosophical reasoning was to explain why things happen. Modern science, with its emphasis on explaining how things happen, has its origins in the Renaissance. Galileo emphasized the method of controlled experiment, which has since formed the basis of all scientific investigation. A generation later Newton carried this method further to explain many of the processes of nature under a mechanical model with well-defined cause-and-effect relationships.

Thus modern science had its beginnings only 300 years ago; yet since that time man's ability to understand his

environment has grown at an accelerating rate. Recent advances in the techniques of research in science and applied technology have replaced the simpler process of invention and have aided the explosive growth of modern industrial societies.

SCIENCE IN MODERN SOCIETY

The twentieth century has seen enormous advancements in science and technology which have affected the life of everyone. Prior to the industrial revolution in Western Europe and America, increasing scientific knowledge was rarely, or at best slowly, translated into useful forces for the material betterment of man. Since 1850, however, the lag between discovery and utilization of scientific knowledge has been decreasing. Moreover, a growing share of scientific and technological effort has been devoted to applied research. Thus, science has become a pervasive force in modern society, having widespread influence over all of man's activities. It affects the life and decisions of individuals in selecting a place to live, in adapting to a work environment, and in buying an automobile, appliance, or other goods. It has had a tremendous impact upon his social institutions—his family, his church, his schools, and his recreational activities.

Scientific and technological achievement has an obvious impact upon business organizations; indeed, they have been primary institutions in the translation of these achievements into goods and services, fundamental indicators of the standard of living. Almost every industry has seen major advancements not only in its products but also in the means of production. Scientific and technological advancements have greatly conditioned decisions made by various levels of government on many matters, including national defense, foreign policy, health, education, and welfare. Hardly a facet of man's existence or of his social systems has escaped their all pervasive influence.

In the United States, advancing science and technology have been utilized markedly for production of goods and

services to satisfy human needs. During the nineteenth and twentieth centuries, expanding population, settlement of the frontier land, large-scale immigration, and increasing material wants and needs provided a growing source of demand which pushed productive capacity to its limit. This underlying demand stimulated efforts to develop new products and efficient production processes necessary to fulfil the needs. Vast untapped resources facilitated this process of industrialization, and the moral and political ethic of the period provided an atmosphere conducive to maximum efforts toward material betterment and a higher standard of living. Our society was favourably inclined toward adaptation and change—a situation infrequently found in other, more restricted cultures.

Thus, the United States provided fertile ground for the exploitation of advancing technology and the changing social structure stemming from the industrial revolution. Mass-production technology, exemplified by Henry Ford's automobile assembly lines, applied science and technology not only to the product itself but, even more important, to the means of production. Improved methods and techniques were adopted by numerous other industries and provided the basis for turning out vast quantities of consumer and industrial products to meet the growing needs of an expanding economy. This mass-production required the intelligent compromise between advancing technology and innovations and the necessity for standardization and interchangeability.

The vast quantities of material required during World War I emphasized the need for adopting mass-production techniques to many new products, both military and civilian. Pressure during this crisis fostered more rapid technological innovations than would have been forthcoming in normal times. Many of the techniques developed during the war were carried over to the accelerated industrial development of the 1920s.

The Depression of the 1930s came as a major shock to those who had envisioned America's entrance into the

"Golden Age". The advancing science and technology of the past period had a major part in the over-expansion of capital equipment and productive capacity which led to this maladjustment in the nation's economy. The Depression dramatically emphasized that scientific advancements and technological applications were inexorably interwoven with all other elements of American society. Previously it was assumed that the advancement of science and technology was a self-sustaining endeavour and that it operated somewhat independently of other elements of our society. The depression re-emphasized the delicate balance that exists in an advanced industrial economy between various forces such as consumer demand, productive capacity, scientific advancements and innovations, levels of investment and governmental expenditures, and the more subtle yet, important, effect of the expectations of individual consumers, entrepreneurs, and other groups.

The needs generated by World War II again demonstrated the latent capabilities for scientific and technological achievements. Whereas the 1930s saw advancements in scientific knowledge but limited applications, the war required accelerated applications of existing technology. The United States shook off the lethargy of the Depression and gave evidence of tremendous productive capacity necessary to fulfil the expanding needs. Even more than during the 1920s the post-World War II era saw a substantial carry-over of new products and techniques to the job of satisfying consumer demands. The whole level of science and technology as applied to the production of goods and services had been established on a higher base than in the pre-war period. But the United States was not alone in major scientific and technological advancements.

CURRENT DEVELOPMENTS

The launching of Sputnik I early in October, 1957, dramatized Soviet achievements in science and technology and propelled the world into the space age. Whereas the

United States had assumed world leadership with the developments of the atomic and thermonuclear bombs, the Soviet achievement seriously challenged this role and caused many searching reappraisals. In 1958 the House Committee on Government Operations summarized the problem as follows:

The shock and surprise of the successful Soviet ventures into outer space had this valuable effect: our smug sense of superiority, was shattered. Now we are forced, late as it is, to re-examine our educational system, our defense organization and strategy, and our research and production capabilities. Our foreign aid programs, too, must figure in this reassessment.

Soviet Russia's ability to develop atomic and hydrogen weapons so soon after the United States did should have been warning enough to galvanize our national efforts. Our intelligence of Soviet missile experience should have hoisted higher the red flag of danger. But until the American people read about, and could see for themselves if they cared to look, a luminous metal ball revolving in the heavens, Russians progress in science and production was seriously discounted.

Now the American people must respond to the fact that we have a great and powerful rival in the most complicated technical and industrial fields. They must respond, not in panic, not in diffuse and wasteful motion, but in a calm and purposeful dedication to the tasks of building up the Nation's strength.[2]

Several years have passed since the Soviet fired the first earth satellite into orbit. For the United States this has been a period of anxiety and critical reappraisal and of strenuous and many-sided efforts to meet this challenge. Although the United States has responded with the launching of similar satellites, the Russians have continued to lead the way via the lunar probe, manned orbital flight, and other firsts.

New emphasis has been placed upon scientific training and education. Congress passed the Defense Education Act. The President's Science Advisory Committee, composed of eighteen distinguished scientists from private life, was established, and a Special Assistant to the President for Science and Technology (currently Dr. Jerome B. Wiesner) was appointed. Together these two groups became the nerve center of government science organization. The Federal Council for Science and Technology, composed of high-ranking officers from each of the government agencies with major research and devlopment programs, was established to provide a forum for discussion on matters of common interest, to achieve co-ordination on scientific programs involving more than one agency, and to exercise planning and policy roles in connection with government-wide science and technology matters. A Director of Defense Research and Engineering was established within the Department of Defense to co-ordinate its research program. Advanced research and space exploration gained a prominent position with the formation of two new organizations within the Federal government—the Advanced Research Projects Agency within the Department of Defense and the civilian agency, National Aeronautics and Space Administration. In Addition, special congressional committees were set up in the House and Senate to oversee space programs and scientific endeavors.[3]

This expansion of emphasis on science and technology is reflected by the substantial increase in funds being spent for research and development within the United States. Information from the National Science Foundation indicates a research boom going on throughout the nation. In fiscal year 1947 research and development expenditures totaled \$ 2.1 billion; by FY 1961 they had risen to \$ 14 billion. Within the past five years the funds spent for research in the United States have more than doubled (from \$ 6.4 billion in 1956 to \$ 14 billion in 1961). A substantial and growing proportion of the research and development funds is being provided by the Federal government. In FY 1947 the Federal government provided \$ 500 million or 24 per cent

of the research funds. In 1954 it provided $ 2.7 billion, 53 per cent of the total. During FY 1961 the Federal government provided a staggering $ 9.2 billion, 66 per cent of the nations total research funds.

It is evident that in the years since the end of World War II, science and technology have pushed to the forefront of national life with the Federal government taking an increasing role in this effort. Recently, each year's expenditure has been substantially more than the amount spent for research and development in the entire four decades 1900—1939—and more than the total Federal budget of a generation ago. The largest sponsors of Federal research and development are the Department of Defense, the Atomic Energy Commission, the Department of Health, Education, and Welfare, the National Science Foundation, the Departments of Agriculture, Interior, and Commerce, and the National Aeronautics and Space Administration.

Tremendous growth in Federal funds for research and development places increasingly heavy responsibility upon governmental administrative agencies for the proper allocation and usage of these funds. The President's Science Advisory Committee in a special report on American science emphasized the importance of the role played by the Federal government as follows:

> It is apparent from the size of this effort that the Government exerts a powerful shaping influence on all U.S. science and technology. Not only the nation's security but its long-term health and economic welfare, the excellence of its scientific life, and the quality of American higher education are now fatefully bound up with the care and thoughtfulness with which the Government supports research. If this support is halting and erratic, if it emphasizes mechanism and "hardware" to the neglect of fundamental understanding, if it lavishes money on a few popular fields and starves others of importance, if it fails to encourage exceptional men and exceptional programs, the net result could be an impoverished science and a second-rate technology.

One of the clearest lessons to emerge from the history of science is that various scientific disciplines—seemingly unrelated—have a way of stimulating and fructifying each other in an unexpected manner. This complex back-and-forth interplay is the life and soul of science and technology—there can never be too much of it. The most impractical thing that can be done in designing and directing programs of scientific research is to worry overmuch about how "practical" they are. The secrets and treasures of Nature are hidden in the most obscure and unexpected places. It is clear, therefore, that the strongest scientific program is the program with the greatest breadth and scope. It is impossible to predict from which quarter the next scientific advance will come; but we can try to make sure that the Nation has able people at work across the whole scientific frontier.[4]

PROGNOSTICATIONS

Man's present fantasies will be the realities of the next decade through the advancements of science and technology. The decade of the sixties will see an acceleration of achievements based upon the breakthroughs accomplished in the 1950s.

There are many obvious areas where science and technology will make spectacular strides in the 1950s; in biological and medical research, in nuclear technology, in computers and simulation techniques, in transportation and communication systems, and in space technology. While it is impossible to predict with any degree of reliability the timing of major breakthroughs, it is possible to forecast general progress over the whole range of science. And, such advancement will proceed at an ever-increasing rate and be a major force in shaping the life of mankind.

The proportionate role that the Federal government has played in science and technology will continue to grow. Many of the scientific investigations are so broad and encompass such a wide spectrum of technology that it is difficult for any one private institution to undertake and finance such

ventures. It is therefore likely that the Federal government will provide a growing proportion of research funds, even though private industry, universities, and other institutions may actually perform the research.

In the space age it is becoming more difficult to clearly delineate military versus non-military space projects. And it is becoming increasingly apparent that our efforts in space exploration have an important bearing upon international relationships. As President Kennedy said in his message to Congress on urgent national needs:

If we are to win the battle that is going on around the world between freedom and tyranny, if we are to win the battle for men's minds, the dramatic achievements in space which occurred in recent weeks should have made clear to us all, as did the sputnik in 1957, the impact of this adventure on the minds of men everywhere who are attempting to make a determination of which road they should take.... Now it is time to take longer strides—time for a great new American enterprise—time for this Nation to take a clearly leading role in space achievement which in many ways may hold the key to our future on earth....

I believe that this Nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to earth. No single space project in this period will be more exciting, or more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish.[5]

President Kennedy has continued to emphasize that the nation's prestige and future well-being require that it lead the world's drive into space. Over $ 2 billion has been appropriated in fiscal year 1963 for manned space flight, and it is anticipated that the total cost for a successful lunar landing and return will be from $ 15 billion to $ 20 billion. Certainly, the proposed manned space flight program is the nation's most dramatic, expensive, and exciting scientific

research program of the 1960s. The following schedule indicates the magnitude of the program.

Manned space flight schedule[6]

Mercury	1962
One-day mission	1962—1963
Gemini	1963—1965
Apollo Earth orbital	1964—1966
Circumlunar	1966—1968
Lunar landing (rendezvous)	1968—1970
Lunar landing (direct)	1969—1970

The growing importance of science in modern society is illustrated by the support for the establishment of a separate Office of Science and Technology as a new unit within the Executive Office of the President. Under this arrangement the President would have permanent staff resources capable of advising and assisting him on matters of national policy affected by, or pertaining to, science and technology. The President's message to Congress explaining the new organization stated that:

Considering the rapid growth and far-reaching scope of Federal activities in science and technology, it is imperative that the President have adequate staff support in developing policies and evaluating programs in order to assure that science and technology are used most effectively in the interests of national security and general welfare.[7]

The task of management of advanced science and technology programs is by no means limited to the Federal government. Private industry has certainly been in the fore-front of scientific research. It is most often industry which translates new scientific advancements into practical products; this process is occurring continually and at an accelerating pace. Even in space research private industry is increasing its role. The July 1962, launching of the Telstar communications satellite developed by the American Telephone and Telegraph Company (with the transmission

of television pictures between two continents) demonstrated that the era of space communications was a reality. Congress, after substantial debate, provided for the participation of private industry in this vast new field.

These efforts are an indication of advancements in science and technology and give evidence of the new requirements for managing such complex programs. There is a growing awareness of the need to consider the managerial and administrative problems relating to optimum advancements in science and technology. Thus, pure science and technology cannot stand alone—they are part of the complex environment of the twentieth century and most be integrated into man's overall efforts toward a better society.

THE IMPORTANCE OF MANAGEMENT

Sputnik I, Gagarin's space flight, and other evidences of advancing Russian technology have had far-reaching implications. Not only have we reappraised our military and political position, but the impact has extended to our entire educational system and basic social philosophy. The post dramatic effect has been to stress the importance of science and technology. At times this viewpoint has been overemphasized with the apparent assumption that scientific advancement takes place in an environment devoid of human influence. The concept that "science can save us" is the slogan of the extremists. This concept is far from the truth—the modern society must be well balanced with proper emphasis upon the sciences, the humanities, and the professions. The importance of having a wide but balanced range of human talents in our modern society was emphasized by a group of America's better-known scientists:

Men have always displayed a wide range of physical and mental talents. Different societies have placed different values on these talents—now honoring the holy man, now the warrior, now the poet, now the plutocrat, or the athlete, or occasionally the philosopher. The more primitive societies tend to honor the athlete, the warrior and the mystic; the

more sophisticated ones recognize also the important place played by the intellectual.

Today in America we need a very wide variety of human talents. We need not only farmers and artisans, and clergymen and lawyers; we need also painters, sculptors, nuclear scientists, business leaders, engineers, architects, economists, bankers and politicians. We need a host of other kinds of skills emerge and students must be trained in new professions to cope with new problems. In the United States of a century ago the average person may have needed only elementary instruction in the "Three R's", plus a grain of common sense, in order properly to discharge the duties of citizenship. But today the Three R's and common sense alone are not enough. In the modern world everyone is, to some extent, a specialist. Yet each specialist in a democracy must also be able to deal with problems for which his speciality does not concretely prepare him.

A successful democratic society, in short, must have millions of well-educated citizens who can comprehend what the specialists and the leaders are proposing, and who have a chance to judge these proposals wisely.[8]

A society without this broad background of human talents would be totally unprepared for the future. Even though it were to allocate most of its resources to scientific pursuits and to train the best brains in this direction, the problems of integrating the advancing knowledge into the framework of a complex society would be tremendous. In the past we have been unable to absorb effectively the impact of science and technology upon our society; with increasing emphasis upon science in the future, this problem of integration will be even greater. It is generally necessary for someone other than the scientists to translate achievements into beneficial and usable products or services. And, the achievement of human moral and ethical controls over the utilization of nuclear energy is as important to mankind and represents as formidable a task as the discovery itself.

Channeling human effort on a world-wide basis in the proper direction is obviously a gargantuan task. Even on a

national level, in a society as complex as our own, direction of scientific and technological effort poses an extremely difficult problem. Within this framework, there are individual governmental agencies, industries, companies, and institutions carrying out projects of many types. This conference is concerned primarily with optimum channeling of scientific effort for accomplishing the goals of such individual projects. While the treatment concerns the narrower aspects of management of scientific endeavors, generalizations which develop could be applied to the broader national and international science.

As major scientific projects become more complex, the problems of administration increase geometrically. Scientific advancements in a complex society have required increasing specialization among men and organizational units. The integration of these specialized functions into optimum organizational performance is a critical management responsibility. Furthermore, the growing specialization of functions, although having the advantage of superior specialized performances, does create inflexibilities in organizational relationships.

Rapidly advancing technology has emphasized the need for more effective management. With new product ideas that are continually pushing the state-of-the-art plus rapid obsolescence, the management functions of planning and control are crucial. Accelerating technology has led throughout history to shorter and shorter lifespans for each new generation of products. Planned obsolescence has become a byword in modern industrial society. In addition, the amount of time and money required to design and develop the product and set up production facilities has increased. This longer development cycle has made the management function of long-range planning mandatory in order to minimize the risk of expanding valuable resources on a project with little chance of success.

This relationship is apparent with military weapons. Costs of research and development for the newer missile and

space systems have skyrocketed. Furthermore, some advances have been so rapid that missiles have been obsolete even before they were available for operational use. Although not as spectacular, the rapid pace of change in the civilian sector is also apparent. For example, within a period of less than ten years, black-and-white television went through the cycle of market introduction to market saturation. Market expansion and demand for new products, together with increasing research and development and technological advancements resulting in product innovations, have been major forces fostering an environment of change and the attendant necessity for more effective planning and management.

On the other hand, however, the business organization faced with a changing environment has often found many obstacles which make planning for optimum adaptation difficult. Even technological advances, which themselves are purveyors of change, can create degrees of inflexibility. For example, automation, while requiring major changes for its establishment, results in some inherent inflexibility and increases resistance to change. Automation is not just the replacement of minds and hands with machines and computers—it is an overall system which integrates products research and development, manufacturing processes, distribution methods, and other facilitating activities. Once such a system is developed, it can only meet certain prescribed, co-ordinated needs and remains inflexible to any large-scale adjustments necessary to maximize any input segment.

With a stable environment and small, uncomplicated operations, managerial functions can be carried out relatively easily with a shortrange viewpoint. With a more dynamic environment and large complex units operating in the face of many forces restricting flexibility, these functions become crucial. Since the consequences of any decision have such a broad and lasting impact, management, through its planning function, must strive for the optimal course of action.

Scientific advancements in a highly complex society are partially dependent upon more effective managerial and organizational abilities. Before citing specific examples of the importance of management to technological advancements, it would be well to examine the managerial functions more closely.

A general theory of management which has evolved in recent years focuses attention on the fundamental administrative processes which are essential if an organization is to meet its primary goals and objectives. These basic managerial processes are required for any type of organization—business, governmental, educational, social, or other activity where human and physical resources are combined to meet certain objectives. Furthermore, these processes are necessary regardless of the specialized area of management—production, distribution, finance, and facilitating activities. Although the management process has been described in numerous ways, five basic functions have received general acceptance—planning, organizing, staffing, directing, and controlling. Koontz and O'Donnell present the following description of these functions:

> **Planning:** Planning is the function of selecting the enterprise objectives and the policies, programs, and procedures for achieving them. Planning is, of course, decision making, since it involves choosing among alternatives.
>
> **Organizing:** The organization function of the manager involves the determination and enumeration of the activities required to achieve the objectives of the enterprise, the grouping of these activities, the assignment of such groups of activities to a department headed by a manager, and the delegation of authority to carry them out.
>
> **Staffing:** The function of staffing comprises those activities that are essential in manning, and in keeping

manned, the positions provided for by the organization structure.

Direction: The executive function of direction embraces those activities which are related to guiding and supervising subordinates.

Control: The control function includes those activities which are designed to compel events to conform to plans. It is thus the measurement and correction of activities of subordinates to assure the accomplishment of plans.[9]

Although these five functions are listed and described separately, they should not be considered as independent activities; nor is any exact time sequence implied. Adequate performance of any one of these functions is dependent upon performance of the other four. For example, effective direction and control depend to a major extent upon the adequacy of the organizational structure and the planning process. Thus, the total management function is one of co-ordinating all these five activities to meet the objective of the organization.

These managerial functions are simplified when everyone can focus his attentions upon a narrowly defined, explicit task. For more complicated task requiring specialization of functions it is necessary to manage each specialized area and to integrate the areas into an effective whole. Furthermore, with advancing technology and growing industrial complexities, it is necessary to perform these managerial functions over a very broad spectrum of intracompany, intercompany, and interindustry relationships. Systems management is primarily a managerial and organizational concept adapting these five managerial functions to complex interfunctional and interorganizational relationships.

It is sometimes erroneously assumed that scientific advancement only takes place in the sterile environment of the laboratory. In reality, fruition for most major advancements is not happenstance; rather, it is the result of many

thousands of man-hours coupled with facilities and money, all of which must be directed towards goals and objectives. The direction of these efforts—management—is as vital an ingredient for success as is the scientific effort itself. Both are indispensable to progress. Although the spark of genius can occur within the individual, it is not likely to be implemented without organizational co-operation effectuated through managerial processes. The importance of management is readily discernible in the following examples.

INTEGRATING SCIENCE AND MANAGEMENT

Many companies have large research facilities whose function is applying research findings to specific industrial problems. Colleges, universities, and other institutions are performing both pure and applied research over a broad spectrum. Many scientists are engaged in research in governmental agencies. In each of these situations, the scientist does not work alone—he is supported by management whose primary function is combining the human and physical resources in such a way that scientific and technological advancements can be fostered and utilized effectively. Conflicts frequently arise between the scientist and the manager—but this is normal because each has different objectives. The scientist may be guided primarily by his desire to expand the frontiers of knowledge, whereas the manager must also consider other organizational objectives. Yet, many successful teams of scientists, and managers have been established to carry out complex programs. Many of the more important of these are discussed in this conference.

Examples are presented, both civilian and military, of the integration of science and technology by means of the managerial functions of planning, organizing, and controlling. As a result of the growing complexities and rapid technological advancements of these kinds of programs, it has been necessary to establish new and more effective approaches tc the management of these programs. The management of these complex advanced-technology programs is the primary subject of this conference.

THE PROGRAM MANAGEMENT CONCEPT

This conference is concerned with the problems involved in managing large-scale, complex programs. Specifically, it is concerned with the program management concept—a managerial approach which has been developed to meet the changing requirements.

The program management concept is a dynamic philosophy geared to changing managerial requirements in the research, development, procurement, and utilization of large-scale military and civilian systems. Basically, it is the philosophy of the integration of all the activities necessary to the accomplishment of the primary goals and objectives. It is based upon the integrative and co-ordinative activities of focusing a myriad of functions on the accomplishment of total organizational goals.

A convenient step for understanding the evolution of the program management concept is the product mission concept. Any product, civilian or military, can be thought of as having a mission to perform. Briefly, to fulfil the product mission, it is necessary for the manufacturer to perceive a need, to design or develop a successful product, to produce it efficiently, to stimulate demand for this product, to provide distribution through channels necessary to reach the consumer, and perhaps to educate potential users in proper utilization of the product. The accomplishment of the successful mission for the product can be viewed as a program management problem much broader than just physical production. A product mission is measured in terms of ability to optimize all the functions necessary for its success, rather than just to maximize the efficiency of performance of any one function.

Although there are many complex civilian examples of the necessity for program management, some of the most complex examples are seen in meeting the product mission of many of the new weapon and space systems. Throughout military history there has been a gravitation towards

more complex weapons and military missions. Post-World War II technological developments have changed not only the weapons themselves but also the military missions utilizing them. For example, the B-47, the first jet bomber, and nuclear bombs caused revisions in planning for the role of the Air Force. These medium-range aircraft facilitated the extension of the Strategic Air Command and the implementation of the mission of massive retaliation. In order to establish an effective "force in being" of a weapons system geared to the mission of massive retaliation, it was necessary to integrate the B-47 with overseas bases and nuclear bombs. Therefore, the weapon system needed to accomplish the designated military mission required the integration of a maze of technological, strategic, political, and industrial requirements. The development of ballistic missiles and space systems forced re-evaluation of military missions and focused attention on the necessity for complete integration of all functions involved.

Broadly speaking, there are five basic functions necessary for successful mission acomplishment :

Perception of need
Design-development
Production
Delivery-deployment
Utilization

Regardless of the weapon produced or the time period, these functions must be performed by some agency. However, with increasing weapon complexity has come the need for the establishment of new and more efficient managerial and organizational arrangements for the performance and integration of these functions.

The program management concept evolved from the recognition of a greater need for the timely integration of all the functions pointed out above into a co-ordinated and effective system for successful mission accomplishment.

Under less complicated mission requirements, it was possible to separate the functions and have their performance carried out by separate and distinct agencies. Emphasis was placed upon maximization of the goals set forth for each function, and less consideration was given to optimizing total system performance. The program management concept seeks the optimization of overall system performance and may suboptimize performance of individual functions. Furthermore, this concept requires the establishment of organizational structure to ensure managerial and technical integration.

Adoption of the program management concept has been influenced by rapid technological advancements, changing industrial complexes, the rise of an adverse world power, and critical lead times. The primary purpose of this conference is to investigate new managerial and organizational relationships which have developed around some of the nation's most complex advanced-technology programs.

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